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TITLE: G.fast: KPN requirements for G.fast

ABSTRACT

This contribution addresses requirements from KPN about G.fast. Since many of the agreed requirements are applicable for KPN as well, this contribution concentrates on those requirements from KPN that are currently missing or are not yet agreed within ITU.

1. Introduction

So far, a variety of requirements have been identified by different operators, and several of these requirements have been agreed or are gaining acceptance. Most of them are applicable for KPN as well. There are, however, a few requirement missing or not seen by ITU as essential while they are quite relevant for the Dutch situation. This contribution concentrates on those requirements.

2. The primary application for G.fast in the Netherlands

A typical application for G.fast in the Netherlands is to provide Telco's with a cost-effective answer to competitive solutions from cable operators. Bitrates up to 120Mb/s are currently offered in the Netherlands via existing CATV networks to most end users and these rates are additionally to the many HDTV channels delivered via CATV cabling as well. It is just a matter of time and gradual upgrading before cable operators can offer much higher bitrates to most end users.

Currently a few solutions are available, or will be available soon, to compete with those bitrates.

- ***VDSL2 with vectoring*** and bonding will raise the bitrate offers from Telco's to above 100Mb/s but most of this bandwidth has to be used for HDTV broadcast services. So lower rates will be left for other kind of services.
- ***Full Fiber to the Home*** is another solution, with (virtually) unlimited bandwidth capability, but is currently deployed to only a few percent of the customer premises (home activated). Putting more fiber into the ground to serve all the other customer premises as well requires not only huge investments but is also time-consuming to install.

Therefore there is a need for an alternative that is easier (faster) to install and still capable of offering bitrates up to 1 Gb/s.

Hybrid Fiber to the Home, where the last 200m of existing copper wiring is reused for these bitrates can be the answer that is needed, and is therefore seen as the primary application for G.fast in the Netherlands. This holds especially for apartment buildings and in other areas with dense population. Hybrid FttH with G.fast ***should not be positioned as an interim solution*** towards full FttH, but should offer a long term solution. If hybrid FttH with G.fast can offer bitrates up to 500-1000Mb/s, in up-and downstream direction, and to a significant number of homes then there may not be a need

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to replace it by Full FttH for a very long time. Moreover, if G.fast cannot offer such bitrates then Hybrid FttH with G.fast ***may not be the right alternative*** for full FttH.
Therefore KPN is concerned with all requirements causing a significant limitation of the attainable bitrates, such as coexistence and interoperability with legacy DSL solutions. On the other hand, migration from a legacy situation is also essential for KPN, and we do not exclude that G.fast is deployed from a distribution point, while VDSL2 is deployed from the cabinet and ADSL2plus from the central office, all in the same cable.
Therefore all solutions that are boosting the attainable bitrates are seen as **essential for KPN**, like **bonding** and **vectoring**.

3. Support for bonding should be a mandatory requirement

The availability of a double wire pair, organized in a quad geometry, is quite common in the Dutch access Network. About 58% of the links to about 7 million homes in the Netherlands are implemented as a double wire pair between street cabinets and customer premises. They have been pre-installed in the past as spare wire pair, for offering a second (analog) telephony line when needed. As a result, most of these extra wire pairs are unused and thus available as a bonded second wire pair for DSL equipment. This 58% refers only to those wire pairs that are fully pre-installed, but this number increases to about 95% after digging in the ground and making new splices. Deployment of VDSL2 solutions with bonding has already been started in the Netherlands, and KPN expects to deploy G.fast mainly in cases where bonding is feasible.

Therefore we propose to agree on the following issues in the issues list:

2.4.1	To be Agreed	G.fast shall support a bonding option in the standard	
2.4.2	To be Agreed	Bonding via 2 lines shall have an implementation loss < 5%	

At this moment in time, KPN has no preference on how bonding should be specified for G.fast (in 998.2 style, or as part of the transceiver) as long as it can be implemented with the same stability as without bonding and as with retransmission.

4. G.fast shall not preclude a module size of up to 100

Item 2.1.2.2 was recently agreed within ITU, and raised the module size of 16 port up to at least 48 ports. It states that "*the G.fast specification shall not preclude the implementation of FTO-O module sizes of up to 48 ports*". KPN favors this extension but believes that a maximum of 48 is still not enough.
Moreover, it **is not fully clear what is meant with a "port", a "node" and a "module".**

- Does a combination of two bonded wire pairs count as a single port or as two ports?
- What is the difference between a Node and a Module, if any
- Is a Node a combination of one or more Modules in a single housing?
- Can multiple modules be combined into a box with a single uplink?
- Can multiple modules with multiple fiber-optic uplinks be combined into a single vector group?
- Can multiple modules be powered from a single end user?
- Are they all assumed to be in a single vector group or not?

For the time being, we are using the following terminology:

- A **port** is a connection to a single wire pair, and if two wire pairs are bonded then two ports are involved as well.
- A **module** is a set of ports in a common housing, where cooperation among the ports is not precluded by the specification. So if vectoring is implemented, the specification does not prevent that all ports are in the same vector group. Bonded wire pairs are always connected to (different) ports in the same module.
- A **node** is the combination of one or more modules at the same location. Vectoring among ports in different modules is not supported. The use of multiple housing for multiple modules is not precluded as well.

The uplink of a node may consist of one fiber connected to all the modules, but the use of multiple uplink fibers is not precluded. Modules can also be fed via multiple uplink fibers, if desired.

An important situation where G.fast is assumed to be deployed in the Netherlands is in high rise apartment buildings. Assume an apartment building of 12 floors, with 12 homes per floor (6 on the front side, 6 on the back side), that are all fed via a double wire pair from the basement. If this basement has a fiber-optic uplink, and G.fast is used in the last copper drop, then the node should serve 12×12=144 homes with 2*144=288 (bonded) wire pairs.
In spite of the high number of homes, the maximum copper length of this configuration is still within 200m. Assume that a floor is 3m in hight, and that a home is 6 m in width then the most distant home on the top floor is within

12×3m+6×6m = 72m from the basement. Assume this is too optimistic and we double all assumptions then the most distant home is still within 144m from the basement.

This use case makes clear that a maximum FTO-O module size of 48 ports is still far too restricted and we believe that this limit should be increased significantly. In some cases, a node may serve hundreds of ports (288 in our example), but this does not mean that all these ports are to be in the same module. Multiple cables will then be involved to connect such a large number of homes with the node.

The specification of G.fast should therefore not preclude that all wire pairs **in the same cable** can be connected to a single module. This allows them to be all in the same vector group when vectoring is implemented. The typical cable sizes in the Netherlands for these cases do not exceed 100 wire pairs, so this value is considered as a realistic upper limit for G.fast modules.

Therefore we propose to agree on the following issues in the issues list:

2.1.2.2	To be Agreed	The G.fast specification shall not preclude the implementation of FTO-O ***module*** sizes of up to 100 ports, where each wire pair counts for one port and where a bonded double wire pair counts for two ports.	

5. G.fast shall not preclude P2P connections to the fiber side.

The number of full FttH deployments is increasing rapidly in the Netherlands, although they are still outnumbered by DSL and cable solutions. A commonly used full FttH topology is a topology where each home is individually connected via two fibers to a centralized distribution point, a so called APOP (Area Point Of Presence). The size of these APOP's if typically in the order of up to 5000 fibers to interconnect up to 2500 homes, and these APOP's are large enough to house the fiber-optic equipment from different (competitive) operators. This approach facilitates that each customer can be served by an operator of its own choice.
Although a point-to-point fiber topology could still be used to interconnect multiple nodes via a PON system, KPN has chosen to interconnect all these fibers as individual links in a P2P system and not as a PON system.

When a hybrid FttH network is being build, it will be very unlikely that this will be implemented as a PON. It is more likely that if an FTO-O node is to serve N homes with $2\times N$ ports, it will be fed from a bundle of N or $2\times N$ fibers (to be future proof) from which only one or a few fibers are actually used. This issue is addressed via issue 1.4 on the copper side of the FTO-O node, but not on its fiber side.

Therefore we propose to agree on the following issues in the issues list:

1.4.x	To be Agreed	The G.fast specification shall not preclude the implementation of FTO-O modules with P2P operation on the fiber side.	

6. Support of legacy via coexistence is required

The specification of G.fast should allow for coexistence with ADSL and VDSL in the same cable on a pure spectral basis. Therefore KPN favors all requirements for supporting start frequencies above ADSL2plus and VDSL2 bands as agreed via issue 2.9.2.3; especially above 2.2 MHz (ADSL2plus), 12 and 17.664 MHz (VDSL2).
The need for coexistence with POTS is not excluded.

7. Support of legacy via interoperability is not required

It would be "nice to have" if G.fast has a special mode where it can emulate vectored and non-vectored VDSL2, or even ADSL2plus. However it will be an undesired feature if such requirement has its penalty for the G.fast performance when disabled. In such a case, KPN prefers to leave such interoperability requirements out of the G.fast specification. Such a functionality can also be implemented by DSLAM equipment having G.fast ***and*** VDSL2 chips on board.

8. Summary

This paper should be presented under the G.fast agenda item, and concentrates on requirements from KPN that are not yet covered or agreed by the issues list. Therefore we propose to add/modify the following issues on the issues list:

1.4.x	To be Agreed	The G.fast specification shall not preclude the implementation of FTO-O modules with P2P operation on the fiber side.	
2.1.2.2	To be Agreed	The G.fast specification shall not preclude the implementation of FTO-O module sizes of up to 100 ports, where each wire pair counts for one port and where a bonded double wire pair counts for two ports.	
2.4.1	To be Agreed	G.fast shall support a bonding option in the standard	
2.4.2	To be Agreed	Bonding via 2 lines shall have an implementation loss < 5%	

We also recommend to define common terminology, and the following terminology may serve as a starting point:

- A **port** is a connection to a single wire pair, and if two wire pairs are bonded then two ports are involved as well.
- A **module** is a set of ports in a common housing, where cooperation among the ports is not precluded by the specification. So if vectoring is implemented, the specification does not prevent that all ports are in the same vector group. Bonded wire pairs are always connected to (different) ports of the same module.
- A **node** is the combination of one or more modules at the same location. Vectoring among ports in different modules is not supported. The use of multiple housing for multiple modules is not precluded as well.

The uplink of a node may consist of one fiber connected to all the modules, but the use of multiple uplink fibers is not precluded. Modules can also be fed via multiple uplink fibers, if desired.